

On a New Dark Field Micrometer, and on the Electric Illumination of an Equatorial at Melbourne. By R. L. J. Ellery, F.R.S.

A new dark field micrometer has been lately made for the 8-inch Equatorial of the Melbourne Observatory, which presents some novel features, and which has been found in practice to be very convenient and remarkably useful in micrometric observations of faint objects. It is arranged to be used either with "dark" or "bright field" illumination; and in the "dark field" means are provided for illuminating the declination or micrometer webs, or the Right Ascension or Transit webs, separately or together. The light is given by a small incandescent lamp of $2\frac{1}{2}$ -candle power, which with a rheostat can be conveniently graduated from a simple glow to the light of two candles, while the light can be sifted by means of coloured glass, light ruby being generally used.

The diagrams will show the arrangement.

The micrometer is of the ordinary modern form, one slide, S' (fig. 1), is movable by means of the micrometer screw (100 threads to the inch), with fixed divided head, h^1 , and a count head, h^2 (fig. 2), actuated by epicyclical tram within the head. This slide carries three webs about 6' apart. The second slide, S'' , carries five webs about 4' 48" apart, and has a very limited motion by means of a screw, k (figs. 1 and 2), with 100 threads to the inch, which can be moved only with a special key. The whole micrometer box is moveable at right angles to the optical axes of the telescope through being attached to the adapting tube by a well-fitting slide, $b b$ (fig. 1), actuated by the screw s^3 , which is opposed by a strong spiral spring c (fig. 1). The eye-pieces are mounted on a slipping-piece moved by the four threaded screws, S^4 (fig. 2).

The illumination.—The adapting tube, T (fig. 2) is $2\frac{1}{2}$ inches diameter and $4\frac{1}{2}$ inches long; at right angles to this is fixed a short tube, T^2 , $2\frac{1}{2}$ " diameter and 2" inches long, to which is fixed the electric lamp, L (fig. 1 and 2), from which light diverges on to lenses l^1 and l^2 (fig. 2), and thence parallelised through a perforated screen, and coloured glass if required, on to four small mirrors, $m m m m$ (fig. 2), fixed, but adjustable, on a diagonal diaphragm. These mirrors reflect four beams up the annular space between the adaptor tube and a smaller inner tube, $t t$ (fig. 2), toward the micrometer box, and exactly upon four small rectangular apertures shown at $a a$ (fig. 1), thence through them to four small mirrors, two of which are seen in fig. 2, $d d$, which reflect a thin beam of light a little from above, but almost precisely in the plane of the wires, giving them a full and symmetrical illumination. To admit of this, the surfaces on which the webs are laid are below the general surface of the slides, which are cut away for the purpose, as shown in fig. 1. In the adapting tube and close to the bisecting slide are four very light shutters, $f f f f$ (fig. 3), which can be closed over either or

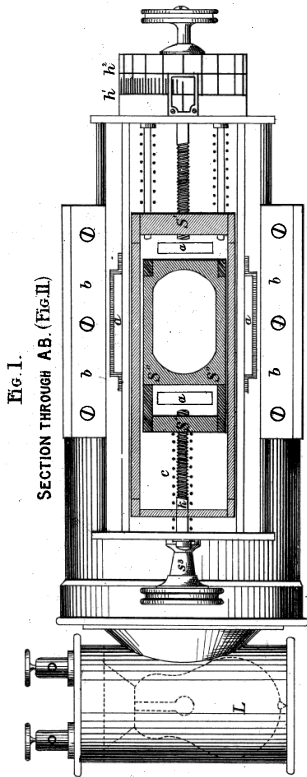
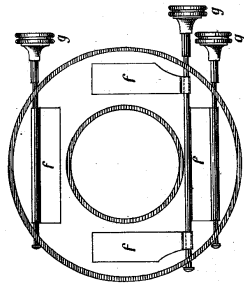
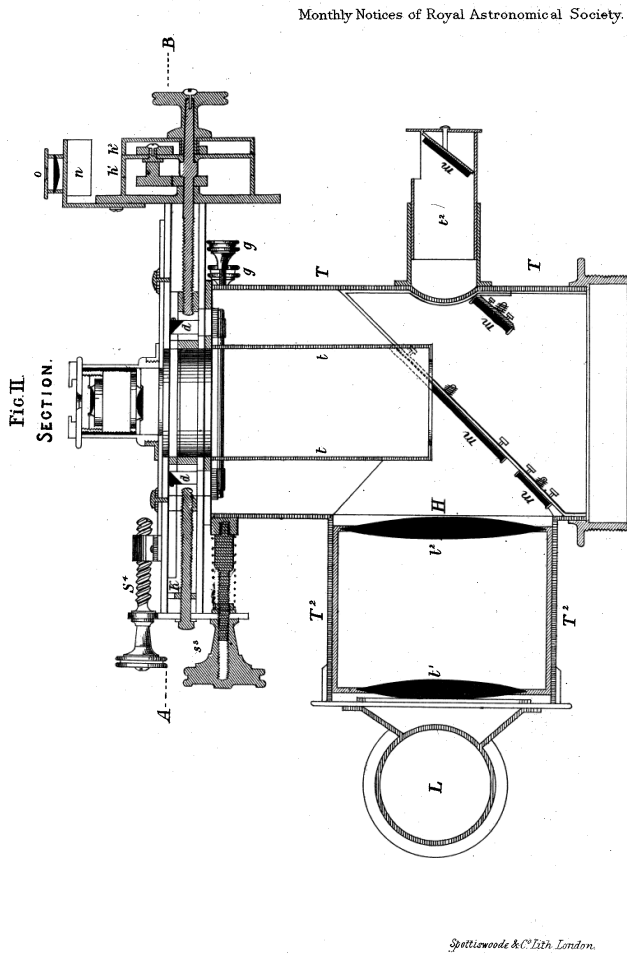


FIG. III.
SHUTTER APPARATUS.



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both pair of openings by means of little milled heads, *g g g* (figs. 2 and 3) behind the micrometer box, so that if required either or both systems of wires can be eclipsed or both illuminated. A further advantage is afforded by this part of the apparatus, which is often an advantage in observing faint objects: the declination or micrometer wires proper can be *half eclipsed*, so that the position of an object may be got by pointing the end of the illuminated wire (which is mid-field) to the object. Objects that are invisible behind a faintly illuminated wire can be thus plainly seen. Of course, by shutting off the lamp *L*, and taking illumination from the ordinary central mirror of the telescope, a bright field with dark wires results.

In micrometer work it is often very inconvenient to be obliged to hold a lamp to read off the micrometer head, and to obviate this the following arrangement is made. In the screen at *H* (fig. 2) is a central aperture which allows a beam to pass into the tube *t*² (fig. 2), carrying a small mirror *m*, which reflects the light into another small mirror (not seen in section), thence to a dead white surface at *n* (fig. 2), giving a nice illumination of the divided heads, which can be read comfortably and conveniently with the little lens *o* (fig. 2). This lens folds back, to be out of the way of the face when using high powers.

There is, however, one inconvenience in this form of micrometer: the distance from the plane of the webs to the plane of the eye-piece slide makes it necessary to bring the eye very close to the plate for the highest powers, but this inconvenience is only relative and presents no absolute difficulty.

As regards the electrical illumination of the telescope, there are five incandescent lamps used in divided circuit, one for the micrometer, as described, one for the declination setting circle, one for microscopes of declination circle, one for central illumination and for position circle, and one for illumination of hour circle microscopes and reader. All these are connected with a small commutator and rheostat, fixed to the declination sector, with a small ebonite handle easily reached while observing. With this arrangement, by turning the handle, any one of the lamps is put in circuit, and the amount of light regulated by pulling or pushing a light-sliding tube on the commutator handle.

The current for the lamps is obtained from a battery of four carbon-zinc elements in bichromate fluid and cells, arranged in cascade. As this form of battery is found very successful for the purpose, it may be useful to describe the arrangement.

Four carbon-zinc elements are mounted on a frame, each set easily removable. This frame is suspended and counterpoised over four large glass cells, arranged in steps, so that when the fluid is 6' high in the first cell it overflows into the second, and so on, and from the fourth it overflows into a portable vessel. The source of fluid supply is a lead-lined box of about four gallons capacity, to which is fitted a glass stop-cock for regu-

lating the flow. The square surface immersed of each element is about six square inches, and the delivery of fluid from two to four quarts per hour, when a very constant and steady light is given. When not in use the elements are lifted out of the cells and the flow of the fluid stopped. The fluid requires renewing as soon as all warmth of colour by transmitted light disappears, but it will produce a steady light until every bit of bichromate is decomposed; by simply increasing the flow as the fluid becomes weaker it will do a great many hours' work before it requires renewing.

Suggestions for Improvements in the Construction of Large Transit Circles. By A. A. Common.

The ordinary well-known form of Transit instrument, considered in regard to the purpose for which it is used, may be taken as the best designed astronomical instrument we have, fulfilling as it does, when of moderate dimensions, nearly all the required conditions. Its chief defect, inherent in the construction usually adopted, is that of flexure of the tube, and in a less degree of the axis itself. If this flexure of the tube is equal on both sides the result is only a slight movement of the optical axis parallel to itself, but if it is unequal then a change of direction necessarily follows. In either case the accuracy of the observation is not affected.

Most probably such permitted flexure would result in some change of direction of the optical axis in a plane not at right angles to the axis; but, at the worst, this resulting error is all that the Transit instrument suffers from.

When, however, this instrument, good as it may be for its own purpose, is made into a Transit Circle by placing on the axis a divided circle for the purpose of determining the direction of the optical axis in a vertical plane, without in any way altering the construction to get rid of the defect spoken of, that would here become of great importance, it cannot be said that all has been done to make it as perfect or as suitable for its purpose as possible, especially as the delicacy and refinement of observation require that the means of the astronomer should be as mechanically perfect as they can be made, so as to reduce to the lowest amount those errors that must always exist in an astronomical instrument.

Believing, as I do, that the Transit Circle, as at present made, is capable of great improvement, I wish to lay before the Society some remarks on the construction usually followed, and to offer some suggestions for consideration.

If we examine the construction of this instrument we find that, generally speaking, it is only an enlargement of the